Marisa: Today is June 14th and we, Rachel and I, Marisa, are interviewing Professor Wilson Wong synthetic biology policies and practices.

Rachel: Alright. Could you please define the term “synthetic biology?”

Wilson: I would say genetic engineering, basically. I would say genetic engineering. It almost always has to involve some kind of genetic engineering. It might or might not need to be in any living cells. It might or might not produce any proteins but it almost certainly involving rearrangement of DNA sequences, that’s how I would say it. Synthetic biology, the goal is--I would say it’s much more goal oriented in terms of it’s slightly less on trying to understand basic principle of biology but more of trying to achieve a specific behavior. That’s probably what I would say of synthetic biology. It’s very, very broad. It almost--it blurs the line between molecular biology and if it involves proteins, protein engineering. There’s a lot of transcription control. Aside from that, I like to tell people who’s not in the field of synthetic biology that I’m working on genetic engineering. I think that’s how I actually go and talk about it. I would say it’s more design driven. That’s about it. People like to say it’s more, it has a more engineering principle applied to it. It’s more rigorous and to some extent, I’m not sure, in a small scale that’s true. If you want to work in a larger scale, in a more complex organism engineering principles applies but mathematics, less relevant, I would say. But aside from that it’s really hard to define, what synthetic biology is.

Marisa: We would have to agree. What would you say synthetic biology means to you? What’s its significance to you?

Wilson: It means...To me, it creates new behavior, especially in living organisms. It doesn’t have to be, but to me it’s a mean to create new behavior in cells. To have greater control over cellular function. I would say you can achieve a lot of these things, these behavior. For a long time people did that with drugs. Let’s say small molecule drugs and proteins biologics. I would say, more and more so, if you want to achieve more complex behavior, especially in something that lives, you have to do genetic engineering. You have to. So in that sense, that’s what synthetic biology allows you to do. So it’s also different than genome editing, per say. Genome editing usually involve basically cutting or adding DNA sequences to the genome. It’s a very difficult thing to do. It used to be. It’s easier now, but the behavior that you can program just on genome editing alone is not sufficient. So, you do need like, for example, you know let’s say control gene expression in a spatial temporal manner responding to drugs that are far more kinetically favorable, have good pK. These require synthetic biology, chemical biology, genome editing, a lot of types and they all work together. For me, synbio, it’s a collection of tools and strategies and philosophy almost, and spirit. Reprogramming cellular behavior to achieve a certain goal, a predefined goal.

Rachel: Thank you. Could you please describe your field of work and why you’re performing research in this field?

Wilson: I’m interested in using synthetic biology to improve therapy. That’s what drives me these days. It used to be just for fun. Ten years ago, it was just the coolest thing. Fifteen! Fifteen actually. Fifteen, was it fifteen? I started in 2001. So, yeah, fifteen years ago it was just like the coolest thing. Now, I see an opportunity where you can improve therapeutics, especially cancer these days. But it goes beyond cancer therapeutics and I think genetic engineering will

play a huge role, synthetic biology and genetic engineering will play a huge role. So, I think in some cases it's possible to use genetic engineered immune cells to cure cancer.
Rachel: That's what you're working on right?
Wilson: Yes.
Rachel: I know Davis Borocki did something like that for senior project in your lab.
Wilson: Yes. So, I'm very excited about the prospect of that. I know other people are as well. So, that's what I'm trying to do. I think it is my--it's an unsubstantiated belief that if I can have great control or complete control over the immune system, I can cure a lot of disease, not everything but…
Rachel: A lot.
Wilson: A lot. I think it will benefit a reasonable amount, a significant number of people. So that's what I'm working on. Trying to figure out all these different ways to control cells, especially immune cells. I don't know what is the best way yet, that's why I'm trying to invent as many different tools as possible and trying to evaluate them. What's the best? What's the advantage and disadvantages of these approaches that I'm developing? Maybe some, one of them, will be useful.
Marisa: Why would you say that the public should care about synthetic biology, the non-scientific community?
Wilson: Oh, it can save their lives. I really think so. There are many, many applications, right? I think the most immediate one...in my line of work, is like, if I'm successful, if I can actually ask the immune cell to go only kill the cancer cell but not the normal tissue, it will save many people's lives. Especially in cancer. I will say most people, unfortunately, they either will have cancer or will know someone that they care about will develop cancer. That's just the way it is these days. I think it could be life saving. It's already proven at least in some cases, whether it is chimeric antigen receptors or acute lymphoblastic leukemia, it's life saving for some of the patients when nothing else worked. On that front alone, I feel like they should care. On a broader scale, I think genetic engineering and synthetic biology can solve a lot of problems. You know for environmental remediations. I think human health, diagnostics like Jim Collins work. It's one great example of diagnostic applications. I don't even want to go into food. These things are very controversial. I believe, you know, improving crops. Yields, resistance to pests and dry conditions they all I think will be important. But you don't want to say "Don't touch my food!" Okay. Fine. I think synbio is still relevant in medicine. That's not even talking about basic science that it can help. That it will eventually lead to better medicine. Yeah, that's why I think the public should know the...I think what's important in the end is know the limitations and the potential of synbio. It's actually overhyped.
Rachel: You think so?
Wilson: To some extent. There's a lot of misconceptions. There's definitely a lot of wong informations.
Rachel: What kind of misconceptions do you think there are?
Wilson: It depends on what field you're talking about. Especially when you talk about food. When you talk about GMOs, there's a lot of misconceptions of what genetic engineering, what it does to the food and how that impacts human health. They think you engineer the crops and then you put in pesticides into the crops and then it's bad for you. I think that's nonsense.

That's ridiculous. So in that context there's a lot of misconceptions. Like people don't want DNA in their food, which is ridiculous. You can't not eat food. I don't know what kind of food you can eat that doesn't have DNA in it. But in terms of even therapy, with the chimeric antigen receptor, with immunotherapy there might be...I'm trying to--I'm bowlish in terms of what I can do. But sometimes I worry that people think it can cure everything. It cannot. So, we have to worry about that. In terms of, well it is basically gene therapy, right?. Luckily, well not luckily, we tend to be less concerned with gene therapy. Life saving life threatening diseases because alternative is worse, suffering and death...I think we can tolerate gene therapy. But I do worry about the promise, like the over promise because we still don't know. I'm sure it will fail at some point. Like some of the things that we think we can do, we can't deliver. Or it takes another ten, fifteen years before we figure it out. We're going to hit some roadblocks for sure. Ethical issues, of course, especially in terms of gene therapy. I don't think it will ever become heritable. But, you know, if someone do something wrong, let's say starts messing with germ lines, that's an issue.

Rachel: So that kind of bleeds into the next question. In terms of synthetic biology and genetic engineering what do you feel like the public is most concerned about?

Wilson: Well, I think in terms of...let's say forget human for now.

Rachel: Alright.

Wilson: Let's just say that if you engineer other organisms, of course, if they are heritable, then you start spreading. You start propagating. And one of the consequences of those kinds of genetic modifications and how they affect the ecosystem, we don't know. And there's no experiment to figure that out. So, I think that's a concern. I think the public is concerned about what they eat, right? "Is it going to hurt my baby?" basically. I think that's the most important thing. If I'm going to feed this genetically engineered corn to my son is it going to hurt him, or hurt my daughter. So I think that's probably what worries people the most. That's how I feel. I would be concerned too if I don't know what's going on. What did you do to my corn? What did you do to the apple that my son's eating? I think designer baby is something that can be troublesome, I think... But what's also problematic is that people don't know. If you do gene therapy, you don't know whether it is heritable. Most people don't understand genetics. So, I think that's a concern. We need to educate, basically.

Rachel: Alright, so what kind of interactions do you have with the non-scientific community and how do you make that non-scientific community interested in your work?

Wilson: Well, I, whenever I talk to anyone who is not in the field I try to focus on therapeutic applications of synbio. I think it's less scary to some extent. We put poisons in people, basically, to treat cancer.

Rachel: Yeah.

Wilson: So, the alternative, gene therapy, is less scary. But whenever you deal with non—problems that even though it's grand, non-life threatening, people get concerned. Like crop yield. It's a big problem. We probably won't have enough food to feed everybody in the future. But it's not something that we worry about now, especially in America. We throw things away all the time. So if you talk about "Oh, you're going to engineer my apple?" Of course they're going to be…I try not to go there, even though I think it is an important problem. So I try to illustrate like synbio…if you don't do these gene therapy type approach, the consequences,

you know it's really, really bad for the patients. And the gain is huge. And it doesn't affect, you know, the people who's not sick. Right?
Rachel: Yeah.
Wilson: So it's not like you fixed the crops here but you messed up the—right, thats the concern. You grow these whatever crops you have and then you mess up the ecosystem. People who have food suffer because we made a mistake somewhere along the way. It's a real concern. I'm not trying to dismiss that. I think it's a real concern.
Rachel: Going back, how many and what kind of interactions do you have with the non-scientific community?
Wilson: Well, there are students, younger who, well I wouldn't say they are non-scientific. The younger students who are not as proficient in the science. Outreach efforts, with museums and things like that.
Rachel: Do you seek those out or do they come to you?
Wilson: They…a little bit of both. People ask us to participate and I don't have to go, right? I go. It's a little bit of both. I don't call up Museum of Science, for example, and say "Hey! Can I do an exhibit?" It's a little bit of both.
Marisa: Is your research publicly funded, like through the NSF or the NIH, or is it funded privately by non- or for-profits?
Wilson: My research?
Rachel: Mmhmm.
Wilson: Oh Both. Mostly …well I get funded by NSF, NIH, and private companies.
Rachel: Does the majority of your funding come from the federal government?
Wilson: Yeah.
Marisa: And would you say you're receiving adequate funding to accomplish your research?
Wilson: Do I have adequate funding for my research? Never.
Rachel: Never.
Wilson: Never enough. I have ambitious goals. People think I'm crazy. There's never enough money. Well I guess not not enough. I could always use more funding to do things I want to do. I want to have complete control over the immune system, right. Yeah, I can always use more people to help me do that.
Rachel: That makes sense. Alright. Going back a little bit again, it's more with the previous question, but do you feel that you personally, adequately reach out and inform the non-scientific community about your work?
Wilson: No, I don't. I don't. That's because I'm kind of a…I don't go out as much as I should, I would say.
Rachel: Do you feel like you don't have the time, or don't have the opportunity, or…?
Wilson: Definitely time. Definitely time. Opportunities, they're there, I feel. Time is a big factor. It's also personality.
Marisa: What would you say is the best way to reach out to the non-scientific community? You said museums before, but do you think there are other modes that would be effective?
Wilson: I guess I hate standing in front of…well, that's not true. Well, I think with these days and age, I guess there's probably a much, there's a mechanism now to reach broad audience. I don't think we are tapping that well, at least my impressions. Or at least I don't see it…I don't

see it done very well from the community, yet. I think what important is, I haven't figured out how to do it, but how do you educate the public about the science. I think that's the most important thing. That involving a lot of…I don't think going out and talk by scientists, like me, will be very effective. It needs to be done professionally, with materials, I guess. If I go out there and go to give a lecture about my science, come on, you know, people are going to fall asleep. I can try really hard to make it more accessible, but I'm sure there are other people who are much better at doing it than I am.

Rachel: So you think there should be a curriculum in schools or something?

Wilson: Like, I would say video, teaching material, like exhibits and the Museum of Science and things like that will be important. Yes, and then also teaching our younger generations, I think that's also important too. I think we've got to start now and if we do well for twenty years, then the world will change because it will influence our policy. The younger kids grow up, they vote, if they understand how things actually work, as opposed to "I don't want food in my DNA" or "I don't want DNA in my food," then…right?

Marisa and Rachel: Yeah.

Wilson: Then you don't get worried about genetically modified food, for example. You don't worry about genetic engineering. It's not common sense to people, what genetic is. If we can change that, that would be important. I mean, that would make a huge difference. I'm not sure how, but it has to be a very organized effort. It's not just me going out there and yap. That would be a disaster, or like film me talking…or that would be…put a video of me on Youtube. You get like five views. People will watch for one minute and then stop. It's like this is the worst thing ever. So I think you can do it well with cartoons and games maybe. There's a lot of different ways. I don't know. I think games would be fun.

Rachel: We agree. A lot of iGEM teams have actually made games before on synthetic biology. It's so interesting. Alright, so do you feel like your research is protected from infringement and does that impact you openness to discuss your work with the general population?

Wilson: My work is…yes, it does. Because I do work in a…well, I work in immunotherapy, which is probably the hottest thing right now in the biotech, in the pharmaceutical world these days. So there is significant commercial interest in what I do. In the field, not in my work, just the field. So, yes, I do have to protect it. I don't feel like I cannot talk to people because of that though. I can talk to people about what I do in general. I just can't tell them the very, very specific of what I do. But I think to the general public, I don't think they really care.

Rachel: But do you feel—oh, sorry.

Marisa: What about to your peers though? To other researchers?

Wilson: Yeah, I do have to hide it a little bit, unfortunately. There's a lot of…at the end of the day it's not so much a…I do…I am thinking about sharing everything without protecting or licensing or anything like that. I'm not sure what is the ramifications of that. At the end, I don't feel like, I'm just going to be honest, at the end I don't feel like my stuff will be a blockbuster or anything like that. But at the same time, things don't get, like therapies don't get developed if nobody can make a dime out of it. Right? If no one can…because it costs so much money to develop. It's not a piece of software where, you know, you can just, where the development cost is not as high a failure rate. Like software doesn't, they don't fail, right? You can fix it. That's how I feel like. People may not like your piece of software but it will work. It will do what

you want to do and if it doesn't you can fix it, but if a drug fails, it fails and it costs so much money. You can't, sometimes you can't fix it and you don't know why. So because of investment, I feel like, people will never push this drug forward if no one can make like any money off of it. It would just sit there. The government's not going to pick it up. Non-profit organization's not going to pick it up. No one has money. So, I think it's important to protect, but I don't think, especially things I do, I don't really develop a therapy for that drug per se. I develop ways to control cells, which can be used in many, many different therapies. So, it's a platform. It should be more open. Ideally, everybody who is doing immunotherapy is using some of the things that I'm doing. It should be enabling technology. So, I do want to be more open. I don't know how to do those things yet to be honest. In terms of policies, in terms of how to structure these kinds of deals I have no idea how to do that.

Rachel: But do you feel like overall, does BU protect your work sufficiently from infringement? You're patented work and you're non-patented work.

Wilson: So far yes. It's pretty standard, I feel like. At the same time I don't have that much work where people are trying to steal yet, I feel. Not yet. It's still very early stage. I don't feel like there are other competitors, who, like any commercial people who are trying to take away…I mean, it's very risky, the things I want to do. So, not yet. I mean maybe, maybe if it works, then I think there will be people, there will probably be issues. But at this stage, I don't feel like. I probably have a harder time trying to convince people to take my stuff, rather than the other way around.

Rachel: That makes sense.

Marisa: And then what regulations do you feel should be in place on synthetic biology? Or--

Rachel: Particularly in your research. Or also—

Marisa: Or also what do you think needs to be lifted?

Wilson: Well, I...well I think definitely no engineering human, in terms of, that can have germ line transmission. I don't believe in that. I don't know. There's a lot of grey area and let's say you know that…Yeah, definitely, no engineering babies for the sake of, like having taller babies or different eye color or something like that. Definitely not that. That's how I feel. The grey area where you know that the fetus is sick or has genetic defects that I…that's a, well that's probably not transmittable, well definitely nothing that can be transmitted. I feel like that can be heritable. That's how I feel. Other kinds of regulations. Pathogen engineering. I think that I don't know, my feeling is that none of us really know what to do, yet. How do you engineer pathogens? How much should you be engineering pathogens? I honestly don't know if the regulations are sufficient or too much to be honest. It's an unknown world.

Rachel: So are you not that familiar with regulations besides the molecular biology—

Wilson: Yeah.

Rachel: and BSL, recombinant DNA?

Wilson: That's true.

Rachel: You don't know much besides what you need to keep your lab—

Wilson: Yeah. I think that's true.

Rachel: in compliance.

Wilson: That's a fair statement to make. Yes.

Rachel: So do you feel like it would be beneficial to have like a pamphlet or something that outlines major policies that may apply to your research?
Wilson: Oh yeah. Yes, I think so.
Rachel: Or a review article that outlines everything? This is excluding recombinant DNA research, because I feel like you are--
Wilson: Yes, those I'm familiar with.
Rachel: because of compliance with your ROHP.
Wilson: I guess I'm thinking about the bigger issues of, not so much the research side. Well, I mean yes the regulations involving the research, but it's you know, it's…I think it's sufficient, I would say, to some extent. But then when things that get, things that can potentially be released from the lab, I think those regulations I'm not too familiar. I don't even know, that's for sure something that I don't know. I don't even know if who, who really thinks about these things. Yeah, I need to figure out whether I agree with them. The things I worry a lot is people who make these policies are not…
Rachel: Fluent in science?
Wilson: Yeah. They're not the practitioner, I would say. They know some, but they're not practitioner. They don't know. One of the things I worry about is, they worry about things that are not feasible anyway. That is my belief.
Rachel: I think that's it. Right?
Marisa: I think so.
Rachel: Oh, I've got one more! So generally, regulation falls under one of three, regulation of synthetic biology falls under one of three federal, what are the called? Divisions? Organizations? The EPA, the FDA, and the NIH. Do you know where you fall under and if you even need to worry about falling under one of these regulatory divisions?
Wilson: Well I deal with health a lot.
Rachel: So you probably—
Marisa and Rachel: NIH.
Wilson: Well, NIH for research and FDA for drug approval. That, I mean, there's no ethical issues, I feel like. Well, for drug approval I know a little bit more of the regulations involved. Of course, in terms of these cell-based therapies, FDA is working hard trying to figure out how to regulate cell-based therapy. So, that's not a unique problem to synthetic biology, the cell-based therapy problem. You try to sell people basically a huge, highly complex problem that is not uniform in quality.
Rachel: That must be a nightmare. But the fact that synthetic biology falls under three agencies, do you think that's clunky and a little bit inefficient? Do you think if there's any way we can change it or--?
Wilson: No. No, I don't think so. I don't think it needs to be changed. I think in the end it's the application of synthetic biology. It's not…because it can apply in many different places. It's like if you have a computer programmed and it controls a medical device, that's got to be regulated by FDA or that certifies medical devices. So, it's not like computer science. How do you regulate computer science, right? You write codes that controls a missile. That's going to have different kinds of regulations. I think synthetic biology is like that. If you're going to engineer food crops, it's going to be EPA, maybe NIH, FDA. But if it's just strictly for medicine then, okay,

FDA. I don't feel like there should be a separate agency or centralized agency specifically for synthetic biology, but then it's going to be so broad that synthetic biology start making materials, for defense applications, then that definitely cannot go into the FDA. I don't know if you can have a centralized agency that can regulate a cell therapy problem. And then let's say someone is making weapons with synbio. I'm not saying I agree with that, but let's say—
Rachel: It's actually illegal to make biological weapons.
Wilson: Sure but—
Rachel: By international treaty.
Wilson: Well I'm not saying you try to use it as an infectious agent, but let's say you make explosive, make material that can be explosive. Or that explodes under water, or something like that. Then, that's a whole different kind of regulations.
Rachel: Yeah.
Wilson: I try not to think about these things. It's too big. The problem is that synbio can address very, very global problems that affect everyone, which is great. That's the power of it. I think that it's great that we're having these conversations about regulations. I try not to get into it because I don't know how to deal with it. That's my problem. I focus on human health, partly because the regulations. It's kind of what's expected, I would say. Even though, I'd say a lot of time it's quality control. It's not an ethical issue. That makes sense.
Rachel: That makes sense.
Marisa: So as we were saying before, we were thinking about making an article, or a brochure, or a pamphlet, or etc. etc. What way do you think, or what mode would be the best way for you to get that information out there, for getting polices and regulations out there so researchers are just more aware of them?
Rachel: Yeah, the best way to present the information about regulations and policies to PIs such as yourself. Brochure? Software program?
Marisa: Video? What would be the best?
Rachel: Review article?
Wilson: A very short video. Well done. Not like some guy like me who starts yapping for like five minutes. I think even less than two minutes video, maybe, with links to, you know the relevant informations. I don't know. The best way I think, is to get people like us to care about it is to get FDA, to get NIH, and NSF, and DARPA, and make every one of us read it.
Marisa: Like make it a requirement?
Wilson: Yes. "We don't fund you if you don't read this."
Rachel: That is funny. Okay.
Marisa: Okay.
Wilson: Then it will be read. It will be memorized. Yeah, if you hit us in the pocket.
Rachel: Phenomenal. Alright. That's all we have for you.
Wilson: Okay.
Marisa: Thank you for allowing us to conduct this interview.
Wilson: Oh yeah. No problem.
Rachel: Yes, thank you so much.
Wilson: Sure, sure, sure, my pleasure.